

Surgical Management of Dissecting Aneurysm

The Use of a Simplified Bypass

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FEW MEDICAL CATASTROPHES are more dramatic in onset, more fulminating in course or more rapidly fatal than dissecting thoracic aneurysm. With our gradually aging population the incidence of this disease is increasing; it is estimated to occur once in every 10,000 hospital admissions.⁵ In recent years major advances have been made in vascular operations, including the surgical management of dissecting thoracic aneurysms. Thus, successful treatment of the disease depends in large part on making a correct clinical diagnosis. The need for early diagnosis is apparent from Hirst's statistics on the survival of patients with this disease.⁵ He and his colleagues found that 21 per cent of patients with dissecting aneurysms were dead within 24 hours of the time dissection began, half within the first four days, three-fourths within the first two weeks and 91 per cent by the end of six months.

The diagnosis is often difficult, especially if the possibility of dissecting aneurysm is not considered. The most classical finding is severe chest pain arising suddenly in a patient with known hypertension. Spread of pain into the upper extremities occurs infrequently. Extension of the dissection characteristically produces symptoms in the abdomen and lower extremities. These may consist of abdominal rigidity or even ischemic changes of the lower extremities. The most common incorrect diagnoses that are entertained are myocardial infarction, perforated ulcer and pancreatitis. Electrocardiographic changes usually show evidences of left ventricular hypertrophy or left axis deviation without the characteristic changes of acute myocardial infarction.

Once dissecting aneurysm is suspected, radiographic studies are particularly useful in substantiating the diagnosis. The classical findings, usually seen on routine films, consist principally of widening of the aortic knob or supracardiac shadow. This sign is particularly useful when previous films of the chest are available for comparison. The false passage produced by the dissecting hematoma may be seen as a double contour in the arch of the aorta, especially

• The alarming mortality in cases of dissecting aneurysm of the aorta has stimulated the development of a surgical technique which results in re-entry of the dissecting channel. During the operative procedure prolonged cross-clamping of the aorta is necessary. While hypothermia will provide protection to the spinal cord and kidneys during reasonable periods of aortic occlusion it will not relieve back pressure on the left ventricle.

By the use of a simple bypass blood is drained from the left atrium into a reservoir and then pumped into the lower aorta via the femoral artery. Thus an adequate supply of oxygenated blood is delivered to the spinal cord and kidneys distal to the occlusion while the left ventricular pressure is decompressed to normal levels. The volume of the shunted blood is simply controlled by monitoring the brachial artery pressure with a cuff sphygmomanometer. This simplified bypass has permitted successful repair of a dissecting aneurysm with complete occlusion of the thoracic aorta for a period of two hours.

ally if intimal calcification is present. These changes may be accentuated by sectional roentgenography.

With the exception of a few scattered reports of surgical attempts to correct this lesion, little therapeutic success was recorded before DeBakey's report in 1955.² DeBakey's procedure is to do by artifice what may occur accidentally to permit an untreated patient to survive, namely the creation of a method for re-entry to the dissecting channel. The re-entry is fashioned by dividing the thoracic aorta, oversewing the distal double lumen, and creating a window between the proximal two channels. The aorta is then reconstructed by an end-to-end anastomosis.

Cross-clamping of the thoracic aorta cannot be performed with impunity. Permanent damage to the cord and kidneys will often result if the thoracic aorta is occluded more than 20 minutes. Cross-clamping of the thoracic aorta also subjects the left ventricle to severe strain, which is poorly tolerated in arteriosclerotic heart disease. In addition, the increase in root pressure may cause a fatal retrograde dissection with hemopericardium.³ While hypothermia will permit considerably longer periods of cross-clamping of the thoracic aorta, it does not diminish the back pressure on the left ventricle. To

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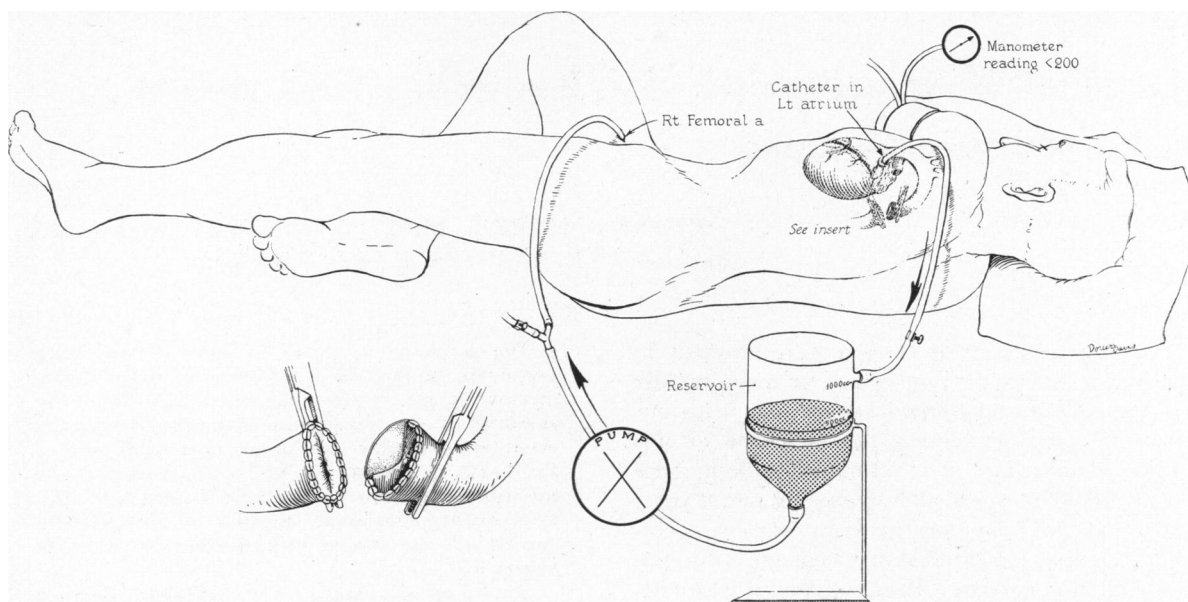


Figure 1.—Diagram showing the details of bypass used. Insert demonstrates the operative technique employed to repair the aorta.

circumvent these difficulties Cooley and colleagues devised an ingenious extracorporeal bypass of oxygenated blood from the left atrium to the femoral artery.¹

In the first two patients in whom we used this technique, several difficulties were encountered. In the first patient there was difficulty in ascertaining the rate of flow through the closed circuit, and in the second patient we did not recognize the necessity of maintaining a root pressure at least equal to the normal blood pressure. In such an event coronary insufficiency is created, which is particularly poorly tolerated in patients of this type. The method we use now is that of Cooley with several modifications. A No. 24 (French) plastic catheter is introduced into the left atrium and is connected by plastic tubing to a siliconized reservoir. A sigmamotor pump is used to return the blood through a tube from the reservoir to the femoral artery. The rate of flow is governed as follows. The atrial line to the reservoir is adjusted by a stopcock so that the arm cuff pressure is maintained at least equal to the patient's normal systolic pressure (Figure 1) or below 200 mm. of mercury. The arm pressure is checked every five minutes by the anesthetist so that the flow from the atrium can be appropriately varied by regulating the stopcock. In this way excessive back pressure on the left ventricle is prevented, while adequate perfusion of the coronary arteries is insured by avoiding an uncontrolled run-off from the left atrium, which would produce a subnormal aortic root pressure. The quantity of blood in excess of that necessary to maintain the normal systolic root pressure is removed from the left atrium

and flows into the reservoir. The pump speed is regulated so that the starting priming level in the reservoir is kept at a constant level. From the reservoir the blood passes through the pump back into the distal aorta by way of the femoral artery. No attempt is made to monitor the femoral artery pressure, as more than adequate perfusion of the kidneys and distal cord is provided by the amounts of blood necessary to keep the aortic root pressure from rising precipitously when the aorta is cross-clamped. In this way the spinal cord and kidneys are nourished adequately for indefinite periods of aortic cross-clamping. General body hypothermia of 32° to 33° C. provides additional safety to the spinal cord and kidneys and permits the bypass to be carried out at lower flow rates.

REPORT OF A CASE

A 57-year-old white man was admitted to the San Mateo Community Hospital on September 6, 1958, with complaint of severe back pain with radiation to the costovertebral angles bilaterally. Eighteen hours previously, while driving to work, he first experienced severe back pain, which soon thereafter radiated vaguely into the abdomen. He also had noted shortness of breath at that time. He was first admitted to another hospital. There the blood pressure was observed to be 190/110 mm. of mercury. He was pale, sweaty, and had a boardlike abdomen. A diagnosis of perforated peptic ulcer or pancreatitis was considered. The serum amylase content was within normal limits and no abnormalities were noted in fluid aspirated from the peritoneum. An

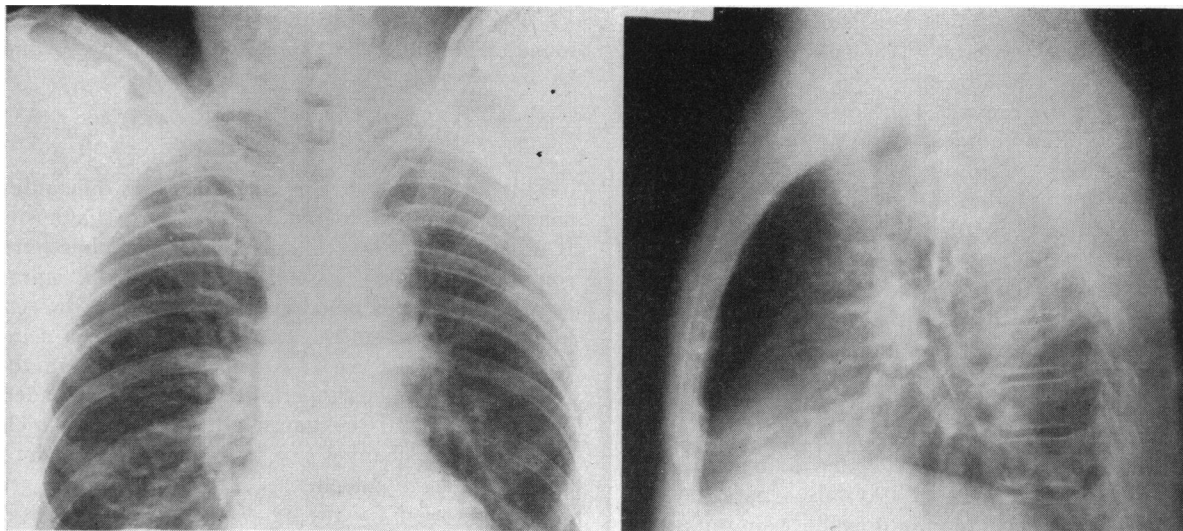


Figure 2.—*Left*, film of chest on entry, interpreted as showing slight aneurysmal tortuosity of the arch and proximal descending thoracic aorta. *Right*, lateral film with similar findings.

electrocardiogram was consistent with left ventricular strain; and a roentgenogram of the chest showed slight aneurysmal tortuosity of the thoracic aorta with slight dilatation of the arch and proximal descending thoracic aorta (Figure 2). The patient was observed overnight and then transferred to the San Mateo Community Hospital for further observation. The clinical diagnosis at the time was pancreatitis.

Upon physical examination at the San Mateo hospital, blood pressure was observed to be 160/120 mm. of mercury. There were no cardiac murmurs, and no abnormal pulsations or peripheral murmurs were observed. Tenderness to deep pressure in the epigastrium was noted. The remainder of the physical examination was within normal limits.

Laboratory studies revealed moderate leukocytosis, hemoglobin content of 12 gm. per 100 cc. and a hematocrit of 40. The reaction to a test of the urine for sugar was 2 plus. No abnormality was noted in the spinal fluid.

Since the amylase content was within normal limits a diagnosis of carcinoma of the pancreas was considered. Observation was continued and on September 12, 1958, x-ray films of the chest taken soon after a recurrent attack of the severe retrosternal and back pain revealed progression in the diameter of the thoracic aortic aneurysm (Figure 3), particularly evident when compared to films that had been taken on February 15, 1955 (Figure 4). It was at this time that the diagnosis of a dissecting thoracic aneurysm was first considered.

On September 14, 1958, under light general anesthesia, hypothermia to 32 degrees C. was induced and thoracotomy was performed through a left postero-lateral incision, with resection of the fifth rib. Preliminary exploration revealed a mass arising in the proximal arch at the origin of the innominate

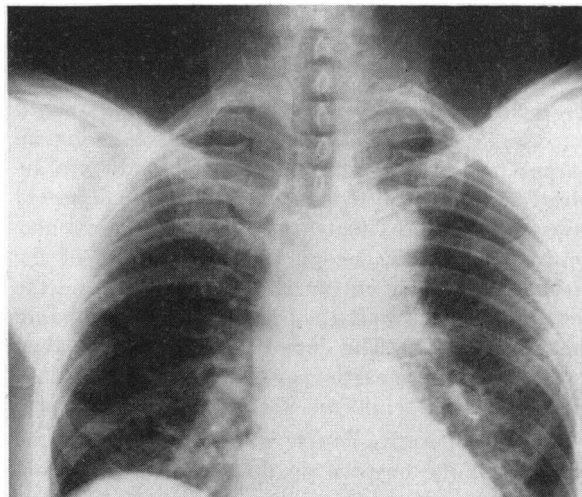


Figure 3.—Film of chest taken September 12, 1958, after a severe recurrent attack of retrosternal pain.

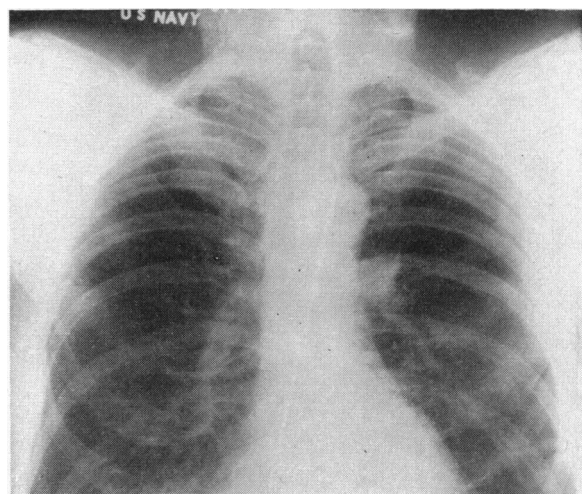


Figure 4.—Routine film of chest taken three years before illness reported herein.

artery, having its greatest diameter just beyond the left subclavian artery. The entire thoracic aorta was involved with the dissecting hematoma to the level of the diaphragm. The aortic arch and proximal descending thoracic aorta were mobilized by dissection.

Heparin was administered intravenously, 3 mg. per kilogram. The plastic catheter leading to the blood reservoir was inserted into the left atrium through the left auricular appendage and was affixed with a purse-string suture. The efferent catheter from the bypass pump was attached to a cannula in the left common femoral artery. With the application of the noncrushing occluding clamps to the thoracic aorta, the left heart bypass was started. The rate of bypass was regulated to maintain the right arm cuff pressure at 190 mm. of mercury. No attempt was made to monitor the femoral artery pressure. The pump speed was adjusted to keep the reservoir level constantly at the starting mark.

The thoracic aorta was transected just distal to the origin of the left subclavian artery. The dissecting hematoma involved the entire circumference of the wall. On release of the distal clamp only slight retrograde blood flow occurred from the false lumen. Large clots and a small amount of blood were aspirated from the false passage and then the dissected layers were approximated by a continuous circular suture. A window encompassing two-thirds of the circumference was cut in the intima above, and the remainder of the wall was then sutured to obliterate the false passage. The ends of the aorta were then anastomosed. The partial cardiac bypass was utilized for 90 minutes while the aorta was cross-clamped.

The postoperative course was uneventful and the patient left the hospital on the seventeenth postoperative day. The blood pressure was 190/130 mm. of mercury. He returned to work as a steamfitter on December 8, 1958. When last seen, on March

19, 1959, he was doing very well; he was asymptomatic, his blood pressure had not changed, and he was working and living a normal life.

DISCUSSION

This case demonstrated very well the difficulties encountered in arriving at a correct early diagnosis. It was only after several successive chest films were compared that the classical widening of the supra-aortic shadow was noted and a diagnosis of dissecting aortic aneurysm was made. This case also demonstrated how the use of a simplified left atrium-to-femoral artery bypass permits periods of extended cross-clamping of the thoracic aorta during which the dissecting channel can be converted back into the central aortic lumen.

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ADDENDUM

One of the authors (JEC) has recently successfully employed this simple bypass in the repair of a traumatic aortic aneurysm with complete occlusion of the thoracic aorta for a period of two hours.

REFERENCES

1. Cooley, D. A., DeBakey, M. E., and Morris, G. C., Jr.: Controlled extracorporeal circulation in surgical treatment of aortic aneurysm, *Ann. Surg.*, 146:473, 1957.
2. DeBakey, M. E., Cooley, D. A., and Creech, O., Jr.: Surgical considerations of dissecting aneurysm of the aorta, *Ann. Surg.*, 142:586, 1955.
3. DeBakey, M. E., Cooley, D. A., Crawford, E. S., and Morris, G. C., Jr.: Aneurysms of the thoracic aorta, *J. Thoracic Surg.*, 36:393, 1958.
4. Gerbode, F., Braimbridge, M., Osborn, J. J., Hood, M., and French, S.: Traumatic thoracic aneurysms: treatment by resection and grafting with the use of an extracorporeal by-pass, *Surg.*, 42:975, 1957.
5. Hirst, A. E., Jr., Johns, V. J., Jr., and Kime, S. W., Jr.: Dissecting aneurysm of the aorta: a review of 505 cases, *Medicine*, 37:217, 1958.

